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Features

# The captivating coral — the origins of early evolutionary imagery

In the 'Origin of Species', Darwin sums up his ideas about the evolutionary process in a single diagram. Tracing the 'evolution' of this diagram reveals a host of sources that may have inspired Darwin's imagination.

**Florian Maderspacher**

Images may help us think, especially when our imagination fails us. Sometimes an image can stimulate us to think in a new, unanticipated direction. A recent book by Horst Bredekamp, a German historian of art, suggests that this is what happened to Darwin when he devised his theory of evolution — he was guided by an image. More surprisingly, the image was not that of the much quoted tree, but that of a coral.

Bredekamp's beautifully illustrated book makes the unusual attempt to understand the development of evolutionary thought by looking at early graphic models of evolution, the images and their sources. Amazingly, Darwin's 'Origin of Species', which builds on a vast number of observations and examples to explain the origin of diversity and variation in Nature, only features a single figure (Figure 1). This figure is a schematic diagram that shows how species change, split up or remain constant over thousands of generations. The generations are represented by horizontal lines, with the oldest at the bottom, much like in geological diagrams. After fourteen thousand generations, from the initial 11 species, 15 have formed that differ to varying degrees from the initial ones. At each horizontal line, the new variants 'bush off' only one or two of which persist. This diagram perfectly captures the crucial concepts of evolutionary change and diversification: new species emerge through gradual change from existing ones, some persist, many perish.

Darwin regarded this single diagram as central to the understanding of his theory. This becomes apparent, as Bredekamp nicely shows, when one looks at the printing template Darwin made of the diagram (Figure 2). It is carefully drawn with labels glued on and it came with detailed instructions for the printers. Darwin, who was much to his own displeasure artistically only mildly gifted, went through great efforts to ensure that this figure was reproduced in the right way. It obviously meant a lot to him. But what inspired it?

The obvious inspiration that comes to mind is the image of a tree. It has become commonplace to talk about trees and branches when referring to patterns of evolutionary descent; after all, trees have been used for ages to depict the genealogies of families. But the image of the tree has inherent features that are fundamentally at odds with Darwin's concepts. Trees tend to grow into one primary direction, upwards. They have a hierarchy of a trunk, large and small branches and twigs. The single direction of growth almost immediately implies a sense of directedness in the process the tree is meant to depict. When talking about evolution, such a teleological component is of course problematic, as evolution has no aim. And indeed, as becomes clear from his writings, Darwin seemed to feel uncomfortable with these ideas.

The other problem with the tree as a metaphor for evolution is that it fails to account for dead, fossil species. At all levels, from the roots to the tip, the tree is alive. It was clear to Darwin that many of the species that have lived on Earth are extinct, but still need a place in a model of evolution. Dead, fossil species are unaccounted for in a tree-like view of evolution, a fact that Darwin noted explicitly and that troubled him.

Darwin wrote in his notebooks: "The tree of life should perhaps be called the coral of life". This idea is also the central punchline of the book by Horst Bredekamp. It traces the evolution of Darwin's diagram in his own sketches, as well as in previous models. Based on this, Bredekamp proposes a provocative idea. In a series of intriguing and well presented arguments, he suggests that the diagram in the origin was shaped after a coral,

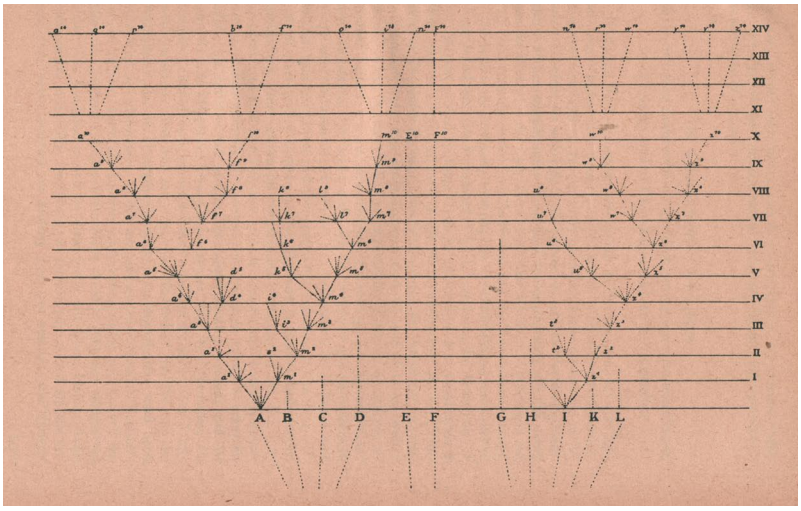


Figure 1. Darwin's dangerous diagram.

This is the single illustration in Darwin's 'Origin of Species', meant to show how from a group of species at the bottom (A–L) over thousands of generations a different set evolves. Some species change, some remain constant some get lost, new ones emerge.

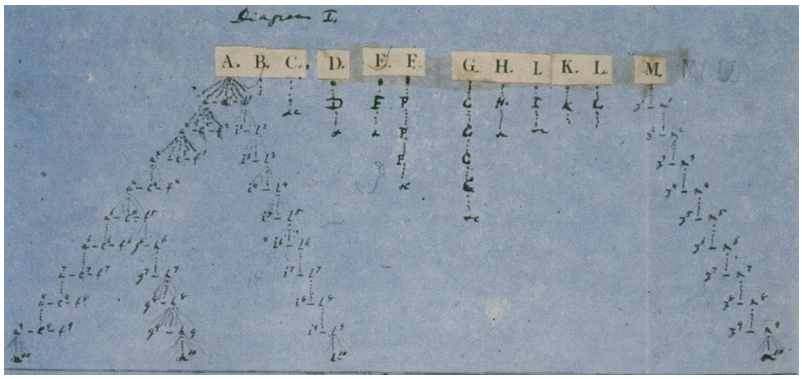


Figure 2. Darwin's hand-made proof of the diagram.
Darwin designed this illustration very carefully and gave detailed instructions for printing, indicating that he regarded it a centrepiece of his work. (With permission from Bredekamp's book.)

notably a specimen Darwin found himself. During a stroll on the shore in Patagonia in 1834, Darwin picked up a brownish, bushy structure which he thought was a coral — ironically, it is now known to be an alga, *Bossea orbignyana*. According to Bredekamp, this very sample became the inspiration for Darwin's diagram in the 'Origin of Species' and thus for one of the most powerful images in the history of science; and Bredekamp means this quite literally.

By looking at early sketches of evolutionary relationships, Bredekamp offers fascinating insights into how Darwin's thinking developed. In his initial, rather clumsy sketches of species formation in 1837 (Figure 3), Darwin drew branched, bushy structures, which were punctate towards the bottom. As inconspicuous as this may seem, it marks, according to Bredekamp, an important leap in thinking, namely that dead forms — fossils — have to be part of the picture of species formation. Bredekamp ascribes this transition in thinking to the use of the coral as a template, whose calcified dead basal branches could be seen as representing the dead fossils compared to living species. For this, the coral would be better suited than the tree, of which all parts are still alive.

The other feature that makes the coral a more attractive model is its topology. The branching pattern of the coral is less hierarchical than that of a tree and it lacks a trunk. It thus would avoid the problem of directedness or teleology, and the coral's bushiness towards all sides would also ensure that the number of species remains roughly constant over time. This can be seen in Darwin's sketch, famously titled 'I think' (Figure 4). The structure in the diagram features comparable numbers of branches representing species at each level of branching and it branches out to all sides with no sign of a clear direction. Bredekamp nicely analyses these early sketches and highlights their important features, which is perhaps the main merit of the book.

Taking his analysis one step further — and probably one step too far — Bredekamp looks at a part of the diagram in the origin and argues that it is a perfect match to the very sample of the supposed coral Darwin picked up in Patagonia. He does this by overlaying images and comparing sizes (Figure 5), but it is questionable if this overlay would be better than the match to any random branched structure. That the image of the coral stayed with Darwin all these years, helped him think and, eventually, found its way into the highly formalised diagram of the most important book in biology is certainly a charming idea, but maybe not much more than that.

On this thin evidence for topological similarity Bredekamp builds a rather heavy conceptual framework, namely that by being taken out of its natural context the 'coral' was transcending into an object of art. It somehow enters a new realm where new meanings can be attached to it, meanings which it did not have before; and it was — according to Bredekamp — part of this meaning that helped Darwin devise his image of evolution. In that sense, the fact that a coral was chosen as the template for the diagrams partly influenced the way Darwin's theory developed.

In contrast to this notion, Julia Voss, a historian of science, on whose work also Bredekamp relies to a large extent, shows how the roots of Darwin's diagrams trace back to previous visualisations. Voss points out important sources from three fields: embryology, taxonomy and geology. It is easy to see why these fields would have been pertinent to Darwin's theory. One critical influence on Darwin were the diagrams of Martin Berry (1772–1876), which were intended to depict how species specific traits form gradually during embryonic development. Voss convincingly shows that Darwin's 'I think' diagram is, down to the details, highly similar to Berry's diagrams, even though something different is depicted.

A second important influence on Darwin were the taxonomic 'maps' of Hugh Strickland (1811–1853), with whom Darwin was in close contact and whom he even intended to trust his scientific heritage should he die before him. Strickland had drawn maps to chart the relationships of extant species, much like newly discovered lands were charted at the time.

It was clear to Darwin that any account of the evolution of life would have to include extinct species as well as extant ones.

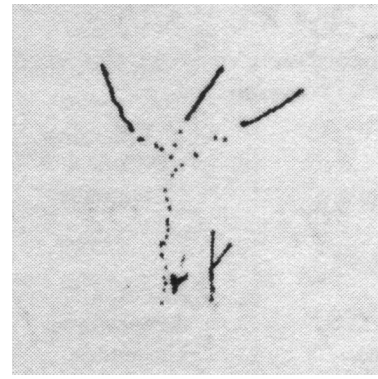

Figure 3. The coral of life?
This minute sketch of the major divisions of life is dotted towards the bottom, with the dots representing fossil forms. A notion that may have been inspired by the use of a coral as a template, rather than a tree. (Reproduced with permission from Bredekamp's book.)

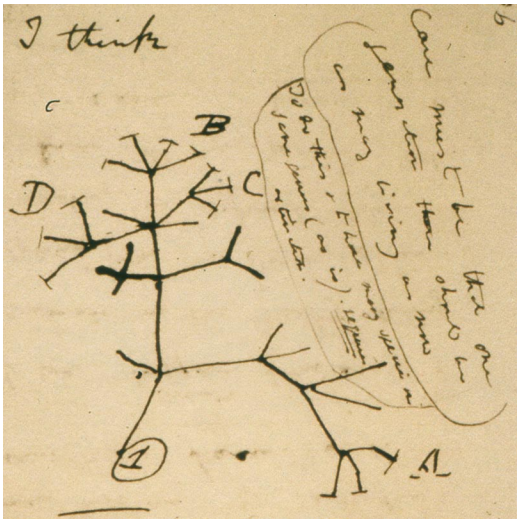


Figure 4. 'I think'.
This early sketch by Darwin features branches going out to all sides, suggesting it was not based on the image of a tree. (With permission from Bredekamp's book.)

Thus, geology was a natural inspiration for his thinking and, as Voss shows, so were the diagrams of the geologist Louis Agassiz (1807–1873). Agassiz' leaf-like diagrams, the likes of which can still be found in textbooks today, depict the changing abundance of a given species over time in the fossil record. They start out as slim lines, bulge as the species fossils become more abundant, and fade out when the species disappears from the fossil record. Agassiz arranged these leaf-like shapes as originating from a centre and one can clearly see this topology reappearing in Darwin's sketches.

Voss' analysis of the influence of other model images seems more parsimonious and better documented than Bredekamp's coral idea. More likely Darwin's sketches were inspired by abstract similarity to the ideas the previous diagrams tried to capture, rather than by shaping them directly after a natural object, such as the coral. There is after all no need to assume that a theoretical concept about Nature would require imagery that is itself directly borrowed from Nature.

Even though Bredekamp's interpretational framework of the coral as a template for Darwin's diagrams may be questionable, the book's main accomplishment is not. The charm of the book lies in its illustrations. It draws attention to these early diagrams, which open a surprising and direct look into the shaping of evolutionary thought in general and of Darwin's idea in particular. Clumsy as his sketches may be, in retrospect, knowing what became of them, they are fascinating. Quite literally, they allow us to watch Darwin think.

Bredekamp's book ends recollecting how Darwin's evolutionary imagery was picked up by his followers, especially the German naturalist Ernst Haeckel (1834–1919). Haeckel, who unlike Darwin was a very skilled artist, gradually transformed Darwin's schematic evolutionary diagram back to a naturally looking tree, crooked and shrub-like first, but in later depictions a strong 'tree of life', perhaps not unsurprisingly looking much like the German national tree, the oak. Haeckel had thus reinstated the concepts that Darwin had tried to avoid in his diagrams, namely the hierarchy and order of trunk, branches and twigs, as well as the sense of directedness. By subtly introducing these notions into evolutionary models, Haeckel may have done the spread of the evolutionary idea more harm than good, even though he was one of the most avid proponents of Darwin's theory.

The coral made one recent and prominent appearance in Stephen J. Gould's last book 'The Structure of Evolutionary Theory'. Gould who was also tree-sceptic used the picture of a coral to represent what he saw as the levels of the basic ideas of Darwinian theory. So finally, the coral had found its proper place in evolutionary imagery and quite explicitly so. Hence, future historians of evolutionary iconography will have perhaps less reading between the lines to do.

Darwins Korallen: Frühe Evolutionsmodelle und die Tradition der Naturgeschichte by Horst Bredekamp. Klaus Wagenbach Verlag: Berlin (2005). ISBN 3803151732.

Florian Maderspacher is Current Biology's reviews editor.

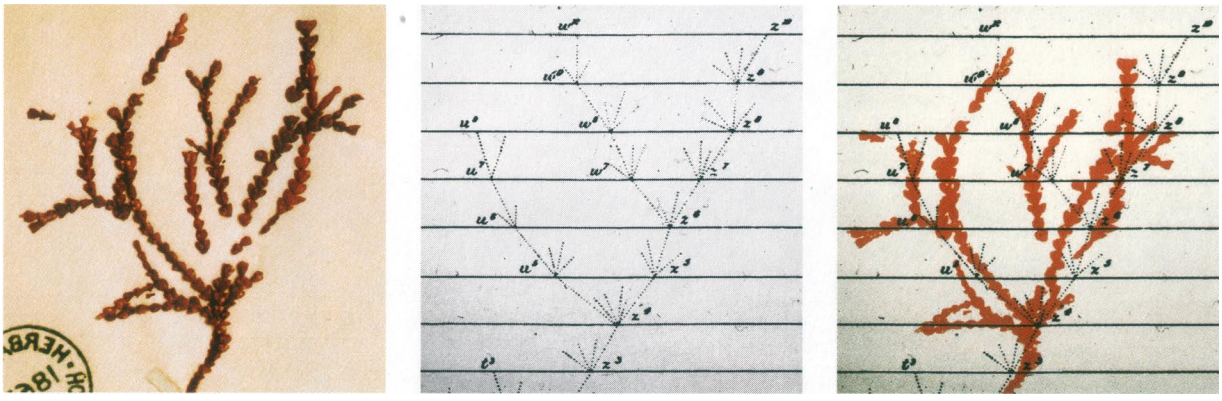

Figure 5. The captivating coral.
According to the ideas of Horst Bredekamp, parts of the diagram in Darwin's origin of species (centre) more or less directly reflect the branching properties of a specimen Darwin collected himself. Bossea orbignyana (left) is now known to be an alga, but Darwin assumed it was a coral. (With permission from Bredekamp's book.)